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LUMBER RECOVERY FROM SECOND-GROWTH DOUGLAS-FIR

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ABSTRACT

Douglas-fir from seven stands of second growth were sawn in a mill which normally processes this type of timber. The logs were scaled by Scaling Bureau and Bureau of Land Management for both Scribner and gross cubic volumes. The recovery ratios were 145 percent for Scaling Bureau Scribner and 123 percent for Bureau of Land Management Scribner. Sixty percent of log cubic volume was recovered as rough green lumber. Approximately 91 percent of lumber recovery was Standard and Better lumber grades.

KEYWORDS: Lumber recovery studies, Douglas-fir, second-growth stands.

CONTENTS

INTRODUCTION

Second-growth stands of Douglas-fir are producing a rapidly increasing proportion of the commercial timber available in the Pacific Northwest. In the Coast Ranges of Oregon (fig. 1), there are large areas of 40- to 100-year-old stands resulting from a sèries of large fires and extensive early logging. Little current information is available on the recovery of forest products to be expected from this resource.

In 1971, the Pacific Northwest Forest and Range Experiment Station, Region 6 of the National Forest System, and the Oregon office of Bureau of Land Management (BLM) in cooperation with Riverside Lumber Company, Champion International, and the Miami Corporation began a study to determine the grades and volumes of veneer and lumber recoveries to be expected from second-growth Douglas-fir. This report contains the lumber recovery information from the study scaled under Scaling Bureau and BLM interpretations. The information will be useful to mill operators and resource managers in allocating cut logs and in making bucking decisions when more than one end product is possible.

STUDY PROCEDURES

SAMPLE SELECTION

Stands were chosen for variation in stand age, stocking, and prior management history. Seven individual stands and 292 trees were selected (table 1) for the lumber sample.

Tree selection varied with stand age. In the 40-, 50-, and 60-year-old stands, we selected trees that would normally be removed in a commercial thinning. In the older stands, we picked trees from the entire range as in a final harvest cut. In all stands, we selected individual trees to sample the variations in size and tree condition. The d.b.h. (diameter 4-1/2 feet above ground level) range of sample trees was from 7 to 44 inches.

THE COOPERATING MILL

Approximately 90 percent of the Riverside Lumber Company mill's production is from second-growth logs. Production is predominantly 2-inch Dimension lumber; however, during the study approximately 49 percent of the lumber produced was 4 inches or thicker.

Table 1.--*Condition of sample stands*

Stand age (years)	Number of trees in lumber sample	Stand level of stocking[1/]	D.b.h. range (inches)	Management
60	45	Medium	8-30	None
80	44	Dense	9-28	None
80	43	Light	9-43	None
50	39	Dense	7-18	None
70	45	Light	8-35	None
100	35	Light	18-44	Commercially thinned 1959
40	41	Medium	[2/]8-20	Precommercially thinned 1959

[1/] Age at which stands closed, based on growth rate slowing to more than 6 rings per inch at stump for dominant and codominant trees: Dense = less than 10 years, medium = 10-20 years, and light = more than 20 years.

[2/] There was one 34-inch tree, about 80 years old, a remnant of a different stand.

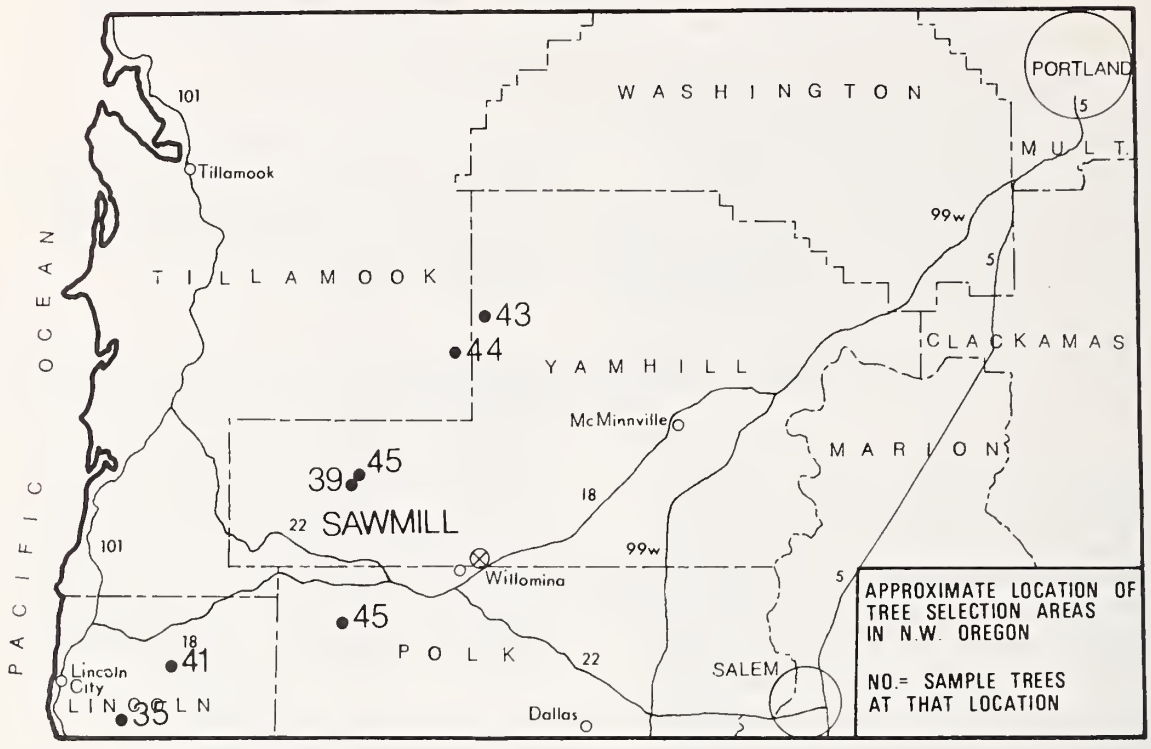

Figure 1.--Approximate location of tree selection areas in northwestern Oregon. Number equals sample trees at each location.

The mill's equipment includes a 30-inch-capacity ring barker and a rosser head debarker for larger logs, a double cut bandsaw, an edger, and a gang trimsaw.

LOG SCALING AND GRADING

The logs were scaled and graded by two methods. The woods-length logs were scaled and graded in the sawmill logyard. Scaling was done by the Forest Service Regional Check Scaler using the Uniform Bureau Rules for West Side.[1/] Under these rules, logs up to 40 feet long are scaled with no allowance for taper, and all fractional inches of scaling diameter are dropped. Logs were graded by the rules for Douglas-fir logs in the standing tree.[2/] Only those defects visible on the log surface were considered in grading.

The second scaling and grading was done after the logs had been debarked and bucked into mill-length logs. This scale, by the Bureau of Land Management Check Scaler, was in compliance with the BLM Manual Supplement 5320 Scaling.[3/] Under these rules, logs up to 20 feet long are scaled with no allowance for taper, and fractional inches of scaling diameter are rounded to the nearest whole inch. These logs were graded by personnel of the Pacific Northwest Forest and Range Experiment Station, Grade and Quality of Western Softwoods Research Project, using the same grades as for the woods-length logs.

The details of log identification, cubic volume computations, sawmill processing, lumber grading, lumber tally, data compilation and analysis, lumber pricing, and chip volume determination are in appendix 1.

RESULTS

The results of the study are presented in a series of figures and tables. In general, the data are presented in a form that allows the user to supply alternative production and pricing assumptions. Recovery ratios and factors are given for both scaling systems. Lumber grade and item recovery will be discussed only for the mill-length logs.

RECOVERY RATIOS AND FACTORS

Recovery ratio.-- Recovery ratio is board-foot lumber tally divided by net log scale and expressed as a percent of log scale. It is equal to overrun plus 100 percent. The study recovery ratios were 146 percent for the Scaling Bureau (woods-length logs) and 123 percent for the Bureau of Land Management (mill-length logs). These ratios varied by diameter (fig. 2), peaking in the 8- and 9-inch log diameter range for either scale. Basic data for recovery ratios and factors are in appendixes 2A and 2B.

Recovery factors.--Recovery factor is board-foot lumber tally divided by log cubic volume. The average recovery factors were 7.12 board feet per cubic foot

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[1/] Official log scaling and grading rules (revised as needed) used by Log Scaling and Grading Bureaus: Columbia River, Eugene, Oregon; Puget Sound, Tacoma, Washington; Gray's Harbor, Hoquiam, Washington; Southern Oregon, Roseburg, Oregon; and Northern California, Arcata, California. Copies may be obtained from any of these Bureaus.

[2/] Log grade descriptions for Douglas-fir. Form R-6 2440-19D, March 1965. Unpublished material on file at U.S. Forest Service, Region 6, Portland, Oregon.

[3/] Unpublished material available from Bureau of Land Management, Oregon State Office, Portland, Oregon.

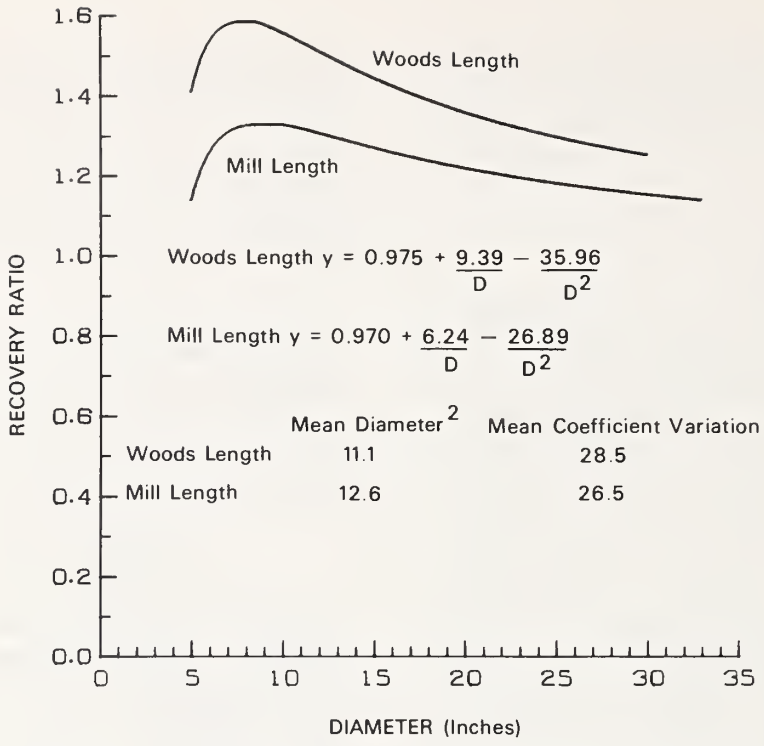

Figure 2.--Recovery ratio: Board-foot lumber tally per board-foot net log scale by log diameter.

for woods-length logs and 7.17 board feet per cubic foot for mill-length logs.

Recovery factors vary with diameter for both woods-length and mill-length logs. Compared with mill-length logs, the recovery factor for woods-length logs was higher for logs less than 15 inches and lower for logs larger than 15 inches in diameter (fig. 3).

The lumber tally for woods-length logs is equal to the lumber tally from mill-length logs. There are two reasons for this variation: first, in woods-length logs fractional inches are dropped, while in mill-length logs fractional inches are rounded; second, the curve forms that describe the shape of logs tend to be convex for top (small) logs and concave for butt logs.[4/] This influences the volume measured when a midpoint diameter is taken, as with mill-length logs. Appendixes 2A and 2B contain the basic recovery factors by diameter.

Cubic volumes of products recovered.-- For both woods-length and mill-length logs, about 60 percent of total log cubic volume was converted to rough green lumber, 9 percent to sawdust, and 31 percent to chippable wood (appendixes 2A and 2B). These volumes varied by diameter class (figs. 4 and 5). For woods-length and mill-length log scales, the variation by diameter for product recovery is similar to that for the recovery factor. The portion of the log converted to sawdust--9 percent--was low. Normally, approximately 11 percent[5/]

[4/] David Bruce. Log volume accounting, weigh scaling and cubic measure. Unpublished paper presented to Society of American Foresters, Coos Chapter, June 15, 1971.

[5/] Paul H. Lane, John W. Henley, Richard O. Woodfin, Jr., and Marlin E. Plank. Lumber recovery from old-growth Coast Douglas-fir. USDA Forest Service Research Paper PNW-154, 44 p. Pacific Northwest Forest and Range Experiment Station, Portland, Oreg., 1973.

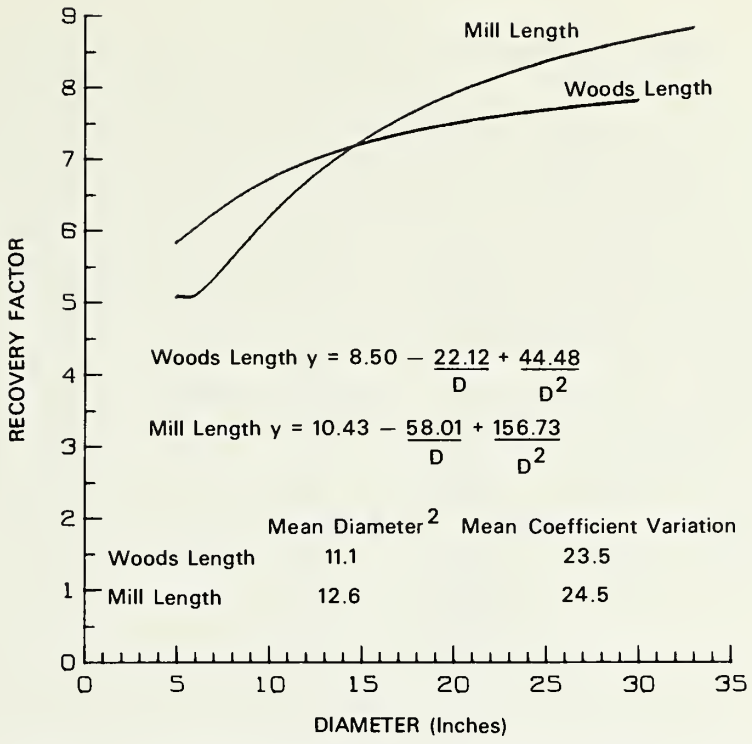

Figure 3.--Recovery factor: Board-foot lumber tally per gross cubic foot of log by diameter.

to 12 percent (see footnote 4) of log volume becomes sawdust. The lower sawdust volume is due to the high percent of 4-inch Dimension lumber produced in this study.

LUMBER GRADE RECOVERY

Lumber grades and sizes.--The lumber grade and item percent recoveries are nearly the same for both woods-length and mill-length logs. Table 2 contains the lumber recovery by grade and item for mill-length logs. Different cull logs were excluded from each scaling system. This changed the percentage recovered in any lumber grade less than 1 percent (table 3).

The lumber produced was predominantly 2-inch Dimension (45 percent) and 4-inch Dimension (47 percent), with the remaining lumber in various items (table 2). The largest volumes were in 2- by 6-inch Dimension (17 percent) and 4- by 12-inch and wider (16 percent).

The high percentage of Select Structural and Construction grades is partially a function of the larger lumber dimensions produced, since size of admissible grading defect increases with lumber dimension.

Lumber recovery by log grade.--The lumber recovery by log grade is included in table 3 for both the woods-length and mill-length logs. The total percentages are slightly different because the logs culled in each scaling system were not identical.

The lumber grade recovery from the four mill-length logs graded No. 3 Peeler is much higher than recovery reported for No. 3 Peeler in old-growth Douglas-fir (see footnote 5). However, with only four observations in the sample, the statistical reliability of this information is very low.

The difference in lumber grade recovery for the No. 2 Sawmill and No. 3

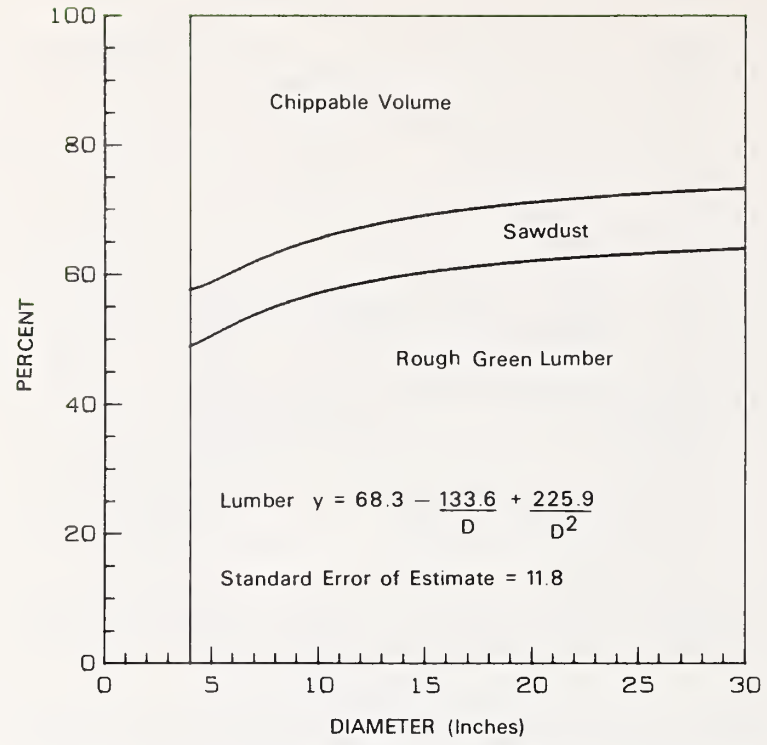

Figure 4.--Cubic volume of log components as a cumulative percent of total cubic volume, by diameter, woods-length logs.

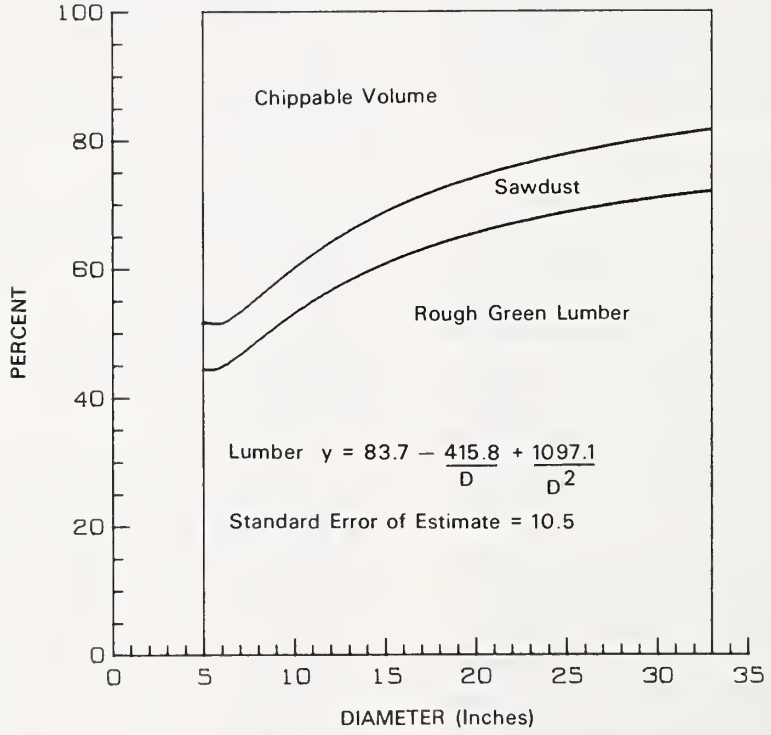

Figure 5.--Cubic volume of log components as a cumulative percent of total cubic volume, by diameter, mill-length logs.

Table 2.--*Percent of total production by lumber grade and dimension*

Dimension (inches)	All sound logs sawn							
	C and Better Select	D Select	Select Structural	Construction	Standard	Utility	Economy	Total
	Percent							
1 x 4	0.05	0	0.06	2.29	0.72	0.37	0.21	3.69
1 x 6	.06	.02	.10	1.92	.46	.13	.04	2.73[1/]
Total	.11	.02	.16	4.21	1.18	.50	.25	6.42
2 x 4	.56	.05	3.01	4.50	3.87	2.02	.22	14.23
2 x 6	.80	.15	4.86	5.86	3.37	1.77	.13	16.94
2 x 8	.09	.04	.52	.50	.32	.47	0	1.93
2 x 10	.81	.05	5.35	3.39	.99	.71	.03	11.32
2 x 12	.06	0	.12	.02	.02	0	0	.22
Total	2.32	.29	13.85	14.27	8.57	4.97	.38	44.64
4 x 4	.03	.05	2.98	5.32	1.47	1.01	.02	10.88
4 x 6	.15	.04	5.53	4.31	1.98	.80	.04	12.84
4 x 8	.10	.04	2.54	2.17	.65	.32	.03	5.85
4 x 10	.09	0	.45	.61	.36	0	0	1.51
4 x 12+	.06	0	7.95	5.81	1.60	.53	0	15.96[2/]
Total	.43	.13	19.37	18.22	6.06	2.66	.09	47.04
6-inch and thicker, 6-inch and wider	0	0	1.63	.23	.04	0	0	1.90
Total	2.87	.45	35.08	36.92	15.85	8.12	.71	100.00[3/]

[1/] Includes 0.04 percent 1 x 8.

[2/] Primarily (12.73 percent) 4 x 14.

[3/] Cross totals may not add due to rounding.

Table 3.--*Lumber grade recovery as a percent of lumber tally volume*

Grade	Number of logs	C and Better Select	D Select	Select Structural	Construction	Standard	Utility	Economy
		Percent						
Woods-length logs[1/]								
No. 2 Sawmill	175	4.20	0.67	35.35	34.51	15.79	8.74	0.74
No. 3 Sawmill	416	.49	.05	34.38	41.15	15.92	7.29	.72
Total or average	591	2.89	.45	35.01	36.85	15.84	8.23	.73
Mill-length logs[1/]								
No. 3 Peeler	4	57.72	7.72	28.14	2.47	1.30	1.53	1.12
No. 2 Sawmill	438	2.55	.39	35.10	36.60	16.67	7.98	.71
No. 3 Sawmill	675	.76	.22	35.39	39.49	14.63	8.81	.70
Total or average	1,117	2.87	.45	35.08	36.92	15.85	8.12	.71

[1/] Percentages of woods- and mill-length logs vary due to cull logs that developed.

Sawmill logs is small. The diameter minimum of 12 inches for No. 2 Sawmill seems to to be the primary consideration in determining log grade.

Lumber grade recovery and log size.--Recovery by lumber grade varied with diameter. As diameter increased, the percent of Utility and Economy lumber, as well as Selects, increased (fig. 6). The No. 3 Sawmill logs had 4 percent more Utility and Economy lumber than the No. 2 Sawmill logs in each diameter class. The percent of Selects increased with diameter much more sharply in No. 2 Sawmill than in No. 3 Sawmill logs. These differences are significant at the 1-percent probability level. Appendixes 3A and 3B contain the lumber recovery by grade and diameter.

LOG VALUES

The product recovery value of a log depends on the grade and item prices. The values shown in table 4 are given only to point up the effect of different systems of volume measurement on value per unit volume. The fitted regression line of value per thousand board feet net log scale is shown in figure 7 for mill-length logs.

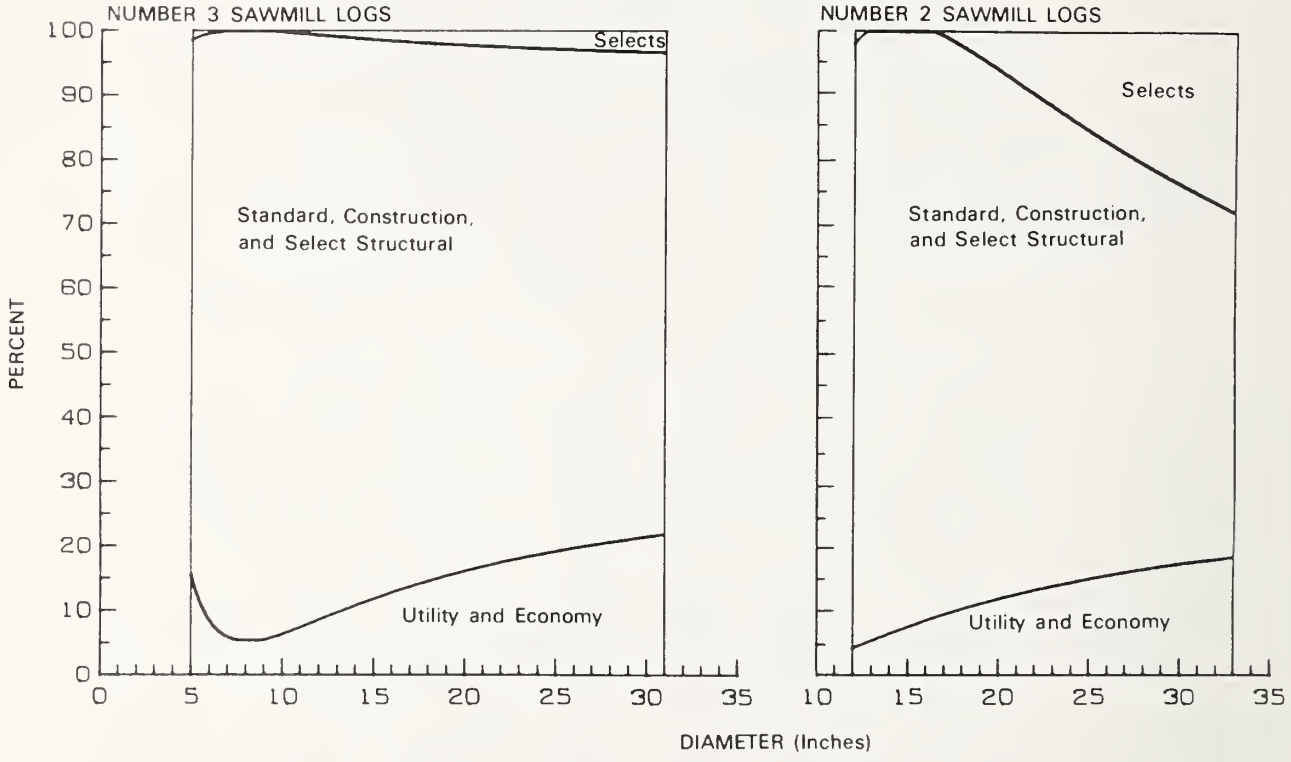

Figure 6.--Cumulative percent of lumber grades by log diameter, mill-length logs.

Table 4.--*Value per unit volume*

Scaling length	Total value	Lumber tally	Lumber tally	Net Scribner scale	Net scale	Gross cubic feet	Gross volume
	Dollars	*Board feet*	*Dollars per thousand board feet*	*Board feet*	*Dollars per thousand board feet*	*Cubic feet*	*Dollars per thousand cubic feet*
Woods-length logs	1/ 15,238.74	148,078	102.92	101,870	149.60	20,807	732.39
Mill-length logs	15,206.95	147,774	102.93	120,420	126.19	20,594	738.42

1/ Small difference in totals are due to different cull logs excluded from the totals.

Table 5.--*Tons of chips per unit of measure, woods-length and mill-length logs*

Scaling	Tons of chips	Scribner scale		Cubic	
		Board feet	Tons/M	Cubic feet	Tons/M
Woods-length	84.51	101,870	0.830	20,807	4.06
Mill-length	84.51	120,420	.702	20,594	4.10

Table 4 shows that the Scribner scales were very different for the two systems, as were the recovery ratios. The cubic scales are less similar than they appear because of the variation in recovery factors with diameter between the two scaling systems (fig. 3).

CHIP RECOVERY

The total chip recovery was 84.51 dry tons of chips, calculated from the mill's chip invoices and measurements of total railcar capacity. There is a marked difference in tons per thousand board feet (Scribner scale) between the woods-length and mill-length logs (table 5). The chip recovery in tons per thousand cubic feet of logs is nearly identical but could be considerably different if the log diameter distribution were shifted in either direction (figs. 4 and 5).

The total chip recovery divided by the total computed cubic volume of chippable material (appendixes 2A and 2B) converts at the rate of 25.84 pounds per cubic foot for woods-length logs and 26.58 pounds per cubic foot for mill-length logs. This figure is comparable to the standard density of 28 pounds ovendry weight per cubic foot of green

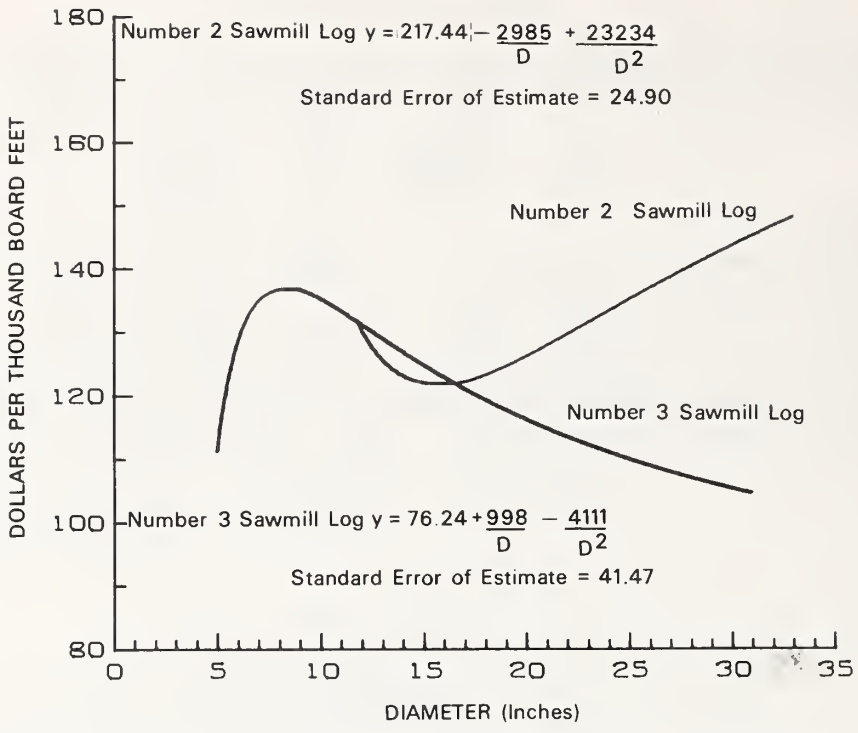

Figure 7.--Value per thousand board-foot net log scale by diameter, mill-length logs.

volume Douglas-fir.[6/] Apparently, computed cubic volume of chippable material was quite accurate if a small volume of actual chippable material can be assumed to be lost either at the barker or as waste.

EFFECT OF GROWING CONDITIONS AND STORAGE TIME

There were differences among stands in density and management; in addition, logs from one stand were in deck storage for approximately 1 year. Covariance analyses were run for recovery ratio and percent of recovery in Utility and Economy lumber grades to see if these differences resulted in any effect on the lumber volume or grade recovery.

In those logs that had been cut nearly a year before milling and then stored in the millyard, end checking to a depth of at least 4 inches was noted. However, there was no significant difference in either percent of Utility and Economy lumber or recovery ratio between these logs and the logs which were freshly cut.

Between stands of medium or dense stocking and those of light stocking, there was a difference in the recovery ratio significant at the 1-percent level of probability. Trees from open-grown stands

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[6/] USDA Forest Service, Forest Products Laboratory. Wood Handbook, No. 72, 527 p. U.S. Government Printing Office, Washington, D.C., 1955.

produced 6.2-percent higher recovery ratio in each diameter class (fig. 8). However, due to the difference in diameter distribution between stands, the mean recovery ratio was only 1.1 percent higher for the open stands than the denser ones.

The percent of lumber recovered in Utility and Economy grades was significantly different at the 1-percent probability level (fig. 9). Essentially, the small logs from open stands produced less low grade lumber than the small logs from closed stands. For logs larger than 9 inches, the open stands produced more low grade lumber than those from closed stands. The mean percent of Utility and Economy for the open stands was 1.3 percent higher than for the closed stands.

Two of the stands had been thinned in 1959, one precommercially and the other commercially. Recovery ratios for these stands were not significantly different from those for other stands. The percents of Utility and Economy grades of lumber were different at the 5-percent probability level. The thinned stands produced 10 percent Utility and Economy lumber, compared with 6.8 percent in the unthinned stands. This is believed to be a result of a combination of diameter distribution and earlier stand history rather than the thinning.

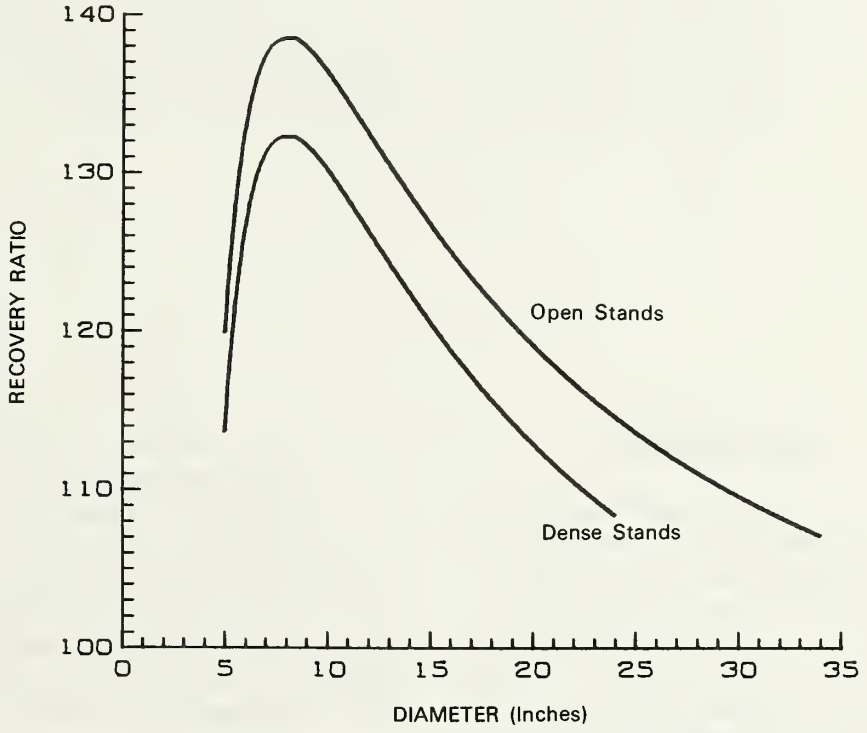

Figure 8.--Recovery ratio by diameter, mill-length logs.

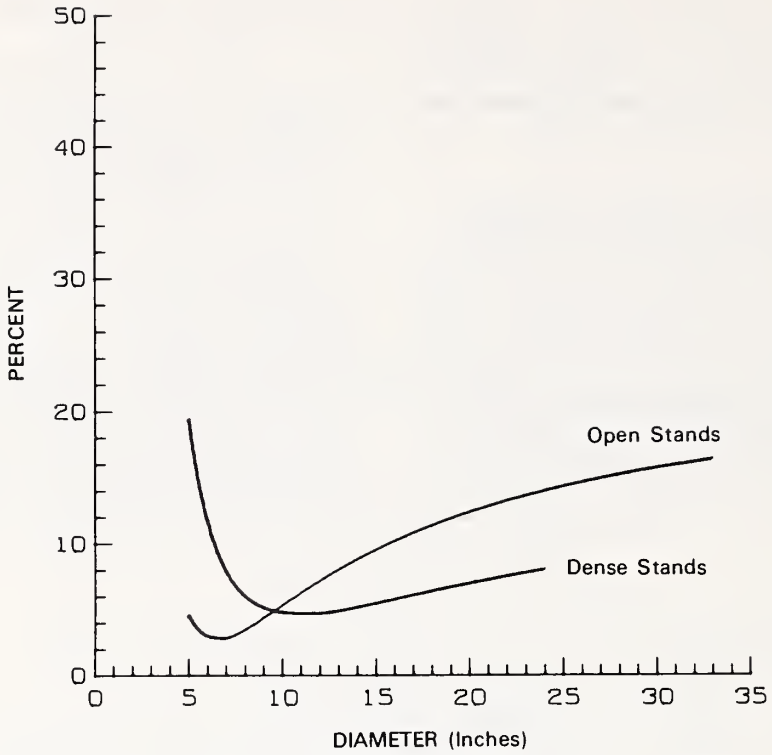

Figure 9.--Percent recovery in Utility and Economy lumber grades, mill-length logs.

DISCUSSION

The differences in Scribner scale between the woods-length and mill-length logs are the critical point to be made. These result in different recoveries of both lumber and chips per unit of volume. The differences in cubic volumes for each scale appear less critical but could be important with a different diameter distribution.

Cubic log volume proved a more precise predictor of lumber recovery than did Scribner scale. This was true for both woods-length and mill-length scales.

There are several factors to consider before applying this information. The sample was selected to take as wide a range of tree size and quality as we could find. A random sample of the same area would average considerably smaller tree and log diameters. Because of this, the fitted regression lines are better estimators than the sample means.

The large volume of 4 by 6 inch and wider caused some lumber grade shifting for two reasons. First, larger grading defects are allowed in larger lumber items. Second, most of the largest lumber items were cut from the center

of the fastest grown logs. Many of these centers could not have met the medium grain requirements for Standard or Better lumber grades on some pieces if cut into smaller items.

For 1- and 2-inch Dimension lumber, yield was 10.7 percent Utility and 1.2 percent Economy. For 4- and 6-inch Dimension, the yield was 5.4 percent Utility and 0.2 percent Economy. For a production run which was primarily 2-inch Dimension, the fitted regression line adjusted for this difference would be a far better estimator of Utility and Economy grades to be expected than the sample mean.

The Select grades which developed in cutting the study logs were primarily in Dimension items. They would ordinarily be sold as part of the Standard and Better lumber grade grouping, particularly when such a small proportion of the total volume is in Select grades. If this were the case, the average value per thousand board feet would decrease slightly with increasing log diameter, while the value per unit volume would be nearly parallel to the recovery ratio curve.

There was no real difference in recovery between the open-grown stands and the denser stands. Their means for both recovery ratio and percent of low grade lumber were nearly identical though arrived at differently. The differences would probably have been greater if all of the production had been in 2-inch Dimension items.

There was apparently no difference between the thinned and unthinned stands due to thinning. None was really anticipated. The stands had been thinned in 1959; they were among the first thinnings done on commercial forest sites by Federal agencies and were fairly conservative.

APPENDIX 1

LOGGING

The trees from Miami Corporation lands were logged in October 1971. The remaining areas were cut in April 1972 and logged June through August of 1972. The log ends were tagged with tree and log identification numbers. All logs were taken to the Riverside Lumber Company logyard and held for sorting, scaling, and processing.

DATA COMPILATION AND ANALYSIS

The data were transferred to punchcards and compiled by a computer program developed specifically for processing lumber recovery data.[7/]

Statistical analysis of data used covariance analysis of multiple linear regressions. Results are reported by grade, only where a statistically significant difference existed. The model selected for the fitted regression lines for all recovery curves was:

$$y = a + \frac{b}{x} + \frac{c}{x^2}$$

because this model consistently gave the lowest residual mean square error.

In analyzing the recovery factors and the lumber grade recovery percents for mill-length logs, the four logs which were graded No. 3 Peeler were included with the No. 2 Sawmill grade logs.

LUMBER PRICES

The lumber prices used in this report are the Forest Service Region 6 appraisal prices for 1970 based on 1969 lumber prices. They are the same prices used in a previous publication on Douglas-fir thinnings.[8/]

The prices are as follows:

	Dollars per thousand board feet
C and Better Select	$219.98
D Select	140.06
Standard and Better[9/]	102.89
Utility (No. 3)	65.62
Economy	38.65

CUBIC VOLUMES

Cubic volumes are based on diameters measured at both ends of the log. On butt logs, the large end diameter recorded was that of a projected conic section and excludes stump flare. Cubic volume is computed by the formula

$$V = \frac{\pi(D_s^2 + D_s D_1 + D_1^2) \times L}{3 \times 4 \times 144}$$

where π = 3.1416
D_s = small end diameter in inches
D_1 = large end diameter in inches
L = nominal length in feet.

[7/] John W. Henley and Jill W. Hoopes. An electronic computer program for calculating sawlog lumber recovery and value. USDA Forest Service Pacific Northwest Forest and Range Experiment Station, 47 p. Portland, Oreg., 1967.

[8/] T. D. Fahey and Douglas L. Hunt. Lumber recovery from Douglas-fir thinnings at a bandmill and two chipping canters. USDA Forest Service Research Paper PNW-131, 9 p. Pacific Northwest Forest and Range Experiment Station, Portland, Oreg., 1972.

[9/] Includes Select Merchantable, Select Structural, Construction, No. 1, Standard, and No. 2 grades of lumber.

SAWMILL PROCESSING

In the woods, each log was given a set of numbers identifying the tree and woods-length log. After bucking, logs were retagged, if necessary, to maintain log identification. An identification number was maintained on each board from the log, through lumber tally.

The 1,117 sawmill-length logs processed during the study were cut from 591 woods-length logs.

LUMBER GRADING

All lumber was graded in the rough green condition by a WCLIB Grades Inspector and assigned its anticipated surfaced green grade.[10/] The Grades Inspector also marked pencil trim[11/] where necessary. Pencil trim was used mainly on boards which were incorrectly trimmed. It was used to upgrade a board only if it was probable that the same decision would be made at the planer trimsaw.

LUMBER TALLY

After the boards were graded, they were tallied by study team members from the U.S. Forest Service and Bureau of Land Management. Each board was tallied by log identification number, grade, width, thickness, and length. Pencil trim was deducted from the length as tallied.

CHIP RECOVERY

Chip recovery is based on the railroad car invoices supplied by the chip purchaser. Three railcars were involved. The first car contained 1-1/2 units of chips from nonstudy logs. In the third car, 81 percent of the available car height was filled with chips from study logs. The volume of chips and the tons of ovendry chips for each car was determined by the purchaser based on gross chip weight and sampled moisture content. The volume and tonnage of study chips were calculated from the invoice of the second car and adjusted invoices from the other two cars. The estimated error is ± 1 b.d.t.

PRODUCT CUBIC VOLUMES

The cubic volume of lumber is based on thickness and width measurements of rough green lumber. Cubic feet of wood converted to sawdust is based on half the measured kerf times the surface area of the boards. Chippable log volume is derived by subtracting the lumber and sawdust volume from log volume.

10/ West Coast Lumber Inspection Bureau. Number 16 Standard Grading Rules for West Coast Lumber. Effective September 1, 1970. Portland, Oregon.

11/ Reduction in board length marked when such remanufacture was probable prior to shipping.

Appendix 2A.--*Recovery ratios and factors for woods-length logs, scale by Scribner Scaling Bureau, all log grades combined*

Scaling diameter (inches)	Number of logs	Total log scale		Percent sound	Lumber tally	Recovery ratio	Log volume	Recovery factor[1/]	Lumber		Sawdust		Chippable	
		Gross	Net						Volume	Percent	Volume[2/]	Percent	Volume[3/]	Percent
		- - - - *Fbm* - - - -			*Fbm*		*Ft*^{3}		*Ft*^{3}		*Ft*^{3}		*Ft*^{3}	
5	59	2,090	2,040	98	2,911	143	490.65	5.93	252.18	51.4	41.11	8.4	197.36	40.2
6	100	5,430	5,400	99	8,133	151	1,387.90	5.86	699.44	50.4	110.56	8.0	577.90	41.6
7	64	3,790	3,680	97	5,981	163	934.46	6.40	515.92	55.2	78.19	8.4	340.35	36.4
8	50	3,510	3,460	99	5,546	160	875.92	6.33	475.95	54.3	69.29	7.9	330.68	37.8
9	52	4,820	4,630	96	7,713	167	1,143.26	6.75	654.40	57.2	96.38	8.4	392.48	34.3
10	46	5,980	5,840	98	8,528	146	1,280.43	6.66	722.32	56.4	110.13	8.6	447.98	35.0
11	36	5,530	5,370	97	7,873	147	1,181.77	6.66	670.34	56.7	103.39	8.7	408.04	34.5
12	36	6,570	6,310	96	9,818	156	1,355.55	7.24	832.59	61.4	121.26	8.9	401.70	29.6
13	25	6,680	6,560	98	9,355	143	1,306.49	7.16	790.10	60.5	113.29	8.7	403.10	30.9
14	27	7,870	7,680	98	11,545	150	1,602.57	7.20	972.87	60.7	142.58	8.9	487.12	30.4
15	15	4,930	4,840	98	7,176	148	935.67	7.67	602.03	64.3	87.09	9.3	246.55	26.4
16	17	6,330	6,230	98	9,184	147	1,170.93	7.84	761.97	65.1	109.73	9.4	299.23	25.6
17	13	6,060	5,810	96	7,920	136	1,083.90	7.31	661.72	61.0	89.87	8.3	332.31	30.7
18	16	8,830	8,520	96	12,178	143	1,548.18	7.87	1,010.30	65.3	141.39	9.1	396.49	25.6
19	13	7,710	7,300	95	9,856	135	1,413.79	6.97	822.69	58.2	111.92	7.9	479.18	33.9
20	1	800	800	100	1,241	155	121.87	10.18	103.85	85.2	12.10	9.9	5.92	4.9
21	4	2,520	2,430	96	3,127	129	399.61	7.83	258.30	64.6	36.64	9.2	104.67	26.2
22	5	4,100	3,940	96	5,238	133	728.11	7.19	434.28	59.6	62.82	8.6	231.01	31.7
23	2	1,500	1,400	93	2,056	147	248.41	8.28	168.62	67.9	24.80	10.0	54.99	22.1
24	0	--	--	--	--	--	--	--	--	--	--	--	--	--
25	4	3,510	2,920	83	4,338	149	509.35	8.52	359.84	70.6	44.89	8.8	104.62	20.5
26	2	2,000	1,940	97	2,376	122	294.62	8.07	197.56	67.1	25.33	8.6	71.73	24.3
27	2	2,890	2,660	92	2,919	110	413.34	7.06	241.19	58.4	33.75	8.2	138.40	33.5
28	0	--	--	--	--	--	--	--	--	--	--	--	--	--
29	1	1,220	1,090	89	1,474	135	203.21	7.25	121.99	60.0	18.12	8.9	63.10	31.1
30	1	1,150	1,020	89	1,592	156	177.35	8.98	133.11	75.1	18.95	10.7	25.29	14.3
Total or average	591	105,820	101,870	96	148,078	145	20,807.34	7.12	12,463.56	59.9	1,803.58	8.7	6,540.20	31.4

1/ Lumber tally divided by gross cubic volume.

2/ Cubic volume of wood made into sawdust.

3/ Log volume minus computed lumber and sawdust volumes.

Appendix 2B.--*Recovery ratios and factors for mill-length logs, scale by Scribner Bureau of Land Management, all log grades combined*

Scaling diameter (inches)	Number of logs	Total log scale		Percent sound	Lumber tally	Recovery ratio	Log volume	Recovery factor[1/]	Lumber		Sawdust		Chippable	
		Gross	Net						Volume	Percent	Volume[2/]	Percent	Volume[3/]	Percent
		- - - - *Fbm* - - - -			*Fbm*		*Ft*^{3}		*Ft*^{3}		*Ft*^{3}		*Ft*^{3}	
5	11	210	210	100	215	102	44.17	4.87	18.51	41.9	3.66	8.3	22.00	49.8
6	98	2,080	2,030	98	2,586	127	502.79	5.14	224.54	44.7	36.98	7.4	241.27	48.0
7	118	3,480	3,350	96	3,924	117	736.61	5.32	342.10	46.4	56.70	7.7	337.81	45.9
8	100	3,010	2,830	94	4,119	146	744.82	5.53	356.75	47.9	54.48	7.3	333.59	44.8
9	136	5,550	5,380	97	7,271	135	1,270.58	5.72	622.50	49.0	92.24	7.3	555.84	43.7
10	108	6,550	6,200	95	7,925	128	1,278.61	6.20	670.77	52.5	98.13	7.7	509.71	39.9
11	74	5,650	5,370	95	6,763	126	1,029.24	6.57	575.06	55.9	88.74	8.6	365.44	35.5
12	83	7,340	7,050	96	9,018	128	1,331.02	6.78	768.13	57.7	118.33	8.9	444.56	33.4
13	73	8,180	7,800	95	9,557	123	1,404.32	6.81	813.43	57.9	117.75	8.4	473.14	33.7
14	55	7,390	7,160	97	9,175	128	1,296.75	7.08	779.81	60.1	109.52	8.4	407.42	31.4
15	43	7,860	7,720	98	8,997	117	1,197.88	7.51	758.72	63.3	110.28	9.2	328.88	27.5
16	41	8,180	7,780	95	9,491	122	1,277.67	7.43	790.08	61.8	118.91	9.3	368.68	28.9
17	36	8,430	8,130	96	9,590	118	1,219.05	7.87	803.33	65.9	114.37	9.4	301.35	24.7
18	42	10,850	10,490	97	13,094	125	1,615.22	8.11	1,090.70	67.5	152.94	9.5	371.58	23.0
19	24	7,140	6,990	98	8,472	121	1,069.26	7.92	706.42	66.1	98.36	9.2	264.48	24.7
20	16	5,600	5,400	96	6,381	118	786.15	8.12	530.16	67.4	72.69	9.2	183.30	23.3
21	10	3,750	3,610	96	4,485	124	538.20	8.33	373.54	69.4	50.43	9.4	114.23	21.2
22	12	4,570	4,440	97	5,000	113	650.85	7.68	415.28	63.8	58.30	9.0	177.27	27.2
23	7	2,930	2,900	99	3,280	113	392.28	8.36	271.57	69.2	36.50	9.3	84.21	21.5
24	8	3,640	3,540	97	4,289	121	513.66	8.35	356.02	69.3	49.28	9.6	108.36	21.1
25	7	3,510	3,170	90	3,629	114	479.09	7.58	297.10	62.0	44.32	9.3	137.67	28.7
26	1	620	620	100	810	131	79.56	10.18	68.01	85.5	7.28	9.2	4.27	5.4
27	3	2,040	1,910	94	2,240	117	260.16	8.61	188.58	72.5	22.41	8.6	49.17	18.9
28	6	3,220	3,140	98	3,633	116	417.10	8.71	297.98	71.4	40.96	9.8	78.16	18.7
29	0	--	--	--	--	--	--	--	--	--	--	--	--	--
30	1	820	820	100	870	106	108.32	8.03	73.50	67.9	9.89	9.1	24.93	23.0
31	1	710	660	93	879	133	89.39	9.83	76.18	85.2	9.68	10.8	3.53	3.9
32	1	740	710	96	734	103	101.00	7.27	61.37	60.8	8.21	8.1	31.42	31.1
33	2	1,180	1,010	86	1,317	130	160.52	8.21	105.42	65.7	17.50	10.9	37.60	23.4
Total or average	1,117	125,230	120,420	96	147,744	123	20,594.27	7.17	12,435.56	60.4	1,798.84	8.7	6,359.87	30.9

[1/] Lumber tally divided by gross cubic volume.

[2/] Cubic volume of wood made into sawdust.

[3/] Log volume minus computed lumber and sawdust volumes.

Appendix 3A.--*Lumber grade recovery percent by diameter, woods-length logs*

Diameter (inches)	Number of logs	Lumber grade							Lumber tally	Value
		C and Better Select	D Select	Select Structural[1/]	Construction[2/]	Standard[3/]	Utility[4/]	Economy		
		Percent							*Fbm*	*$/M L.T.*[5/]
					LOG GRADE NO. 2 SAWMILL					
12	36	0.17	0	36.68	40.02	15.36	6.81	0.96	9,818	99.94
13	23	.56	0	41.35	37.11	15.40	5.33	.25	8,394	101.40
14	26	.71	0	31.95	39.54	17.22	9.98	.60	11,068	99.62
15	15	.28	.15	33.03	40.04	18.83	7.53	.15	7,176	100.37
16	15	1.03	.44	41.95	35.41	17.14	3.46	.57	8,038	102.61
17	13	6.53	.35	39.87	29.10	14.52	8.47	1.15	7,920	106.77
18	16	1.06	.39	41.44	33.66	16.89	6.20	.37	12,178	101.73
19	11	4.70	.17	32.55	33.29	16.13	11.88	1.28	8,406	103.20
20	1	0	0	60.44	30.14	9.43	0	0	1,241	102.88
21	4	7.42	0	23.19	37.29	21.04	10.97	.10	3,127	107.43
22	5	10.18	.76	33.72	27.59	10.79	14.72	2.25	5,238	108.16
23	1	0	2.00	20.60	50.30	19.20	7.90	0	1,000	100.69
24	0	--	--	--	--	--	--	--	--	--
25	3	6.71	2.69	23.57	35.42	13.12	18.28	.20	4,009	104.80
26	2	23.27	2.65	33.59	14.77	15.74	9.13	.84	2,376	127.18
27	2	18.94	6.92	17.51	29.50	17.40	8.77	.96	2,919	123.76
28	0	--	--	--	--	--	--	--	--	--
29	1	25.17	1.70	17.71	22.32	6.24	23.81	3.05	1,474	122.16
30	1	14.45	3.27	42.53	20.85	7.66	10.80	.44	1,592	116.71
Total or average	175	4.20	.67	35.35	34.51	15.79	8.74	.74	95,974	104.32
					LOG GRADE NO. 3 SAWMILL					
5	59	.38	0	27.59	45.93	18.65	5.81	1.65	2,911	100.11
6	100	.57	0	26.29	53.78	15.20	3.93	.23	8,133	101.94
7	64	.12	0	33.02	44.79	16.65	4.18	1.24	5,981	100.67
8	50	0	0	42.93	40.46	11.59	4.78	.23	5,546	100.95
9	52	0	0	41.59	38.29	13.82	5.68	.62	7,713	100.38
10	46	.29	0	41.01	37.70	15.56	4.73	.72	8,528	101.01
11	36	.13	0	31.22	41.61	18.34	8.43	.27	7,873	99.72
12	0	--	--	--	--	--	--	--	--	--
13	2	0	0	32.67	31.53	24.25	11.55	0	961	98.58
14	1	0	0	76.52	12.16	11.32	0	0	477	102.87
15	0	--	--	--	--	--	--	--	--	--
16	2	0	0	10.91	26.96	23.56	35.78	2.79	1,146	87.77
17	0	--	--	--	--	--	--	--	--	--
18	0	--	--	--	--	--	--	--	--	--
19	2	4.34	.83	17.59	34.21	22.00	19.93	1.10	1,450	100.14
20	0	--	--	--	--	--	--	--	--	--
21	0	--	--	--	--	--	--	--	--	--
22	0	--	--	--	--	--	--	--	--	--
23	1	9.00	1.23	37.31	15.25	13.45	23.77	0	1,056	105.02
24	0	--	--	--	--	--	--	--	--	--
25	1	0	0	0	11.55	7.29	68.69	12.46	326	69.27
Total or average	416	.49	.05	34.38	41.15	15.92	7.29	.72	52,104	100.31

1/ Includes Select Structural and Select Merchantable grades.

2/ Includes Construction and No. 1.

3/ Includes Standard and No. 2.

4/ Includes Utility and No. 4.

5/ Dollars per thousand lumber tally.

Appendix 3B.--*Lumber grade recovery percent by diameter, mill-length logs*

Diameter (inches)	Number of logs	Lumber grade							Lumber tally	Value
		C and Better Select	D Select	Select Structural[1/]	Construction[2/]	Standard[3/]	Utility[4/]	Economy		
		Percent							*Fbm*	*$/M L.T.*[5/]
					LOG GRADE NO. 3 PEELER					
24	1	79.35	0	12.09	0	8.55	0	0	339	195.81
25	1	28.59	4.44	65.19	1.04	0	0	.74	675	137.54
26	0	--	--	--	--	--	--	--	--	--
27	0	--	--	--	--	--	--	--	--	--
28	1	75.00	0	20.83	4.17	0	0	0	480	190.71
29	0	--	--	--	--	--	--	--	--	--
30	0	--	--	--	--	--	--	--	--	--
31	0	--	--	--	--	--	--	--	--	--
32	1	63.22	19.35	6.27	3.81	0	4.63	2.72	734	180.63
Total or average	4	57.72	7.72	28.14	2.47	1.30	1.53	1.12	2,228	172.06
					LOG GRADE NO. 2 SAWMILL					
12	80	.14	0	32.80	43.66	17.26	5.24	.90	8,744	100.52
13	71	.46	0	36.87	45.02	14.32	2.88	.44	9,329	102.07
14	49	.23	0	30.23	42.20	19.78	7.32	.23	8,090	100.29
15	42	.44	.13	33.90	39.98	16.40	8.30	.84	8,784	99.82
16	37	.53	0	39.06	35.29	15.97	8.57	.58	8,417	99.95
17	35	.09	.15	41.58	35.95	15.13	6.76	.35	9,265	100.31
18	40	3.09	0	36.86	31.40	22.66	5.55	.44	12,460	104.16
19	22	3.66	.67	36.19	28.56	17.31	12.25	1.36	7,781	101.98
20	16	.19	0	39.96	33.91	17.58	7.30	1.05	6,381	99.71
21	9	6.52	.87	44.50	33.49	8.25	6.37	0	3,926	108.47
22	11	4.80	.98	38.95	39.75	11.03	4.14	.36	4,498	107.11
23	7	1.04	1.28	31.31	32.23	19.97	14.18	0	3,280	99.30
24	5	1.67	0	14.51	46.64	17.04	16.97	3.17	2,811	96.49
25	4	10.91	.87	37.45	31.51	11.44	6.20	1.62	2,291	112.65
26	1	0	0	2.47	47.78	14.44	35.31	0	810	89.73
27	3	11.25	5.49	34.55	17.14	22.72	7.95	.89	2,240	114.57
28	3	9.03	1.14	13.30	41.42	17.16	17.95	0	1,760	107.20
29	0	--	--	--	--	--	--	--	--	--
30	1	2.30	0	24.14	34.48	9.20	28.39	1.49	870	94.05
31	0	--	--	--	--	--	--	--	--	--
32	0	--	--	--	--	--	--	--	--	--
33	2	41.08	3.42	23.23	14.05	2.35	13.44	2.43	1,317	145.69
Total or average	438	2.55	.39	35.10	36.60	16.67	7.99	.71	103,054	102.59
					LOG GRADE NO. 3 SAWMILL					
5	11	0	0	20.47	60.00	8.37	2.33	8.84	215	96.33
6	98	.15	0	21.11	57.70	14.50	6.03	.50	2,586	100.49
7	118	.66	0	18.12	58.94	17.84	2.85	1.58	3,924	101.60
8	100	.27	0	31.32	45.33	15.22	7.04	.83	4,119	100.06
9	136	.32	0	41.30	40.85	12.96	4.43	.15	7,271	101.51
10	108	0	0	44.29	40.50	10.57	4.16	.47	7,925	101.04
11	74	0	0	45.96	33.48	15.26	5.00	.31	6,763	100.83
12	3	0	0	20.80	52.55	22.26	3.28	1.09	274	100.95
13	2	0	0	18.86	21.05	40.35	19.74	0	228	95.53
14	6	0	0	38.71	21.94	28.20	11.15	0	1,085	98.74
15	1	0	0	62.91	30.99	0	6.10	0	213	100.61
16	4	0	0	30.82	36.41	15.83	14.71	2.23	1,074	95.97
17	1	0	0	10.77	21.54	33.54	34.15	0	325	90.15
18	2	.63	0	32.65	17.35	21.61	27.76	0	634	93.28
19	2	9.12	1.74	9.84	54.27	8.39	14.33	2.32	691	107.38
20	0	--	--	--	--	--	--	--	--	--
21	1	0	0	20.04	26.65	10.91	40.97	1.43	559	86.71
22	1	0	0	0	27.09	20.92	51.99	0	502	83.51
23	0	--	--	--	--	--	--	--	--	--
24	2	1.58	0	30.47	15.98	27.66	24.32	0	1,139	95.67
25	2	4.37	0	11.16	22.02	15.69	40.57	6.18	663	88.91
26	0	--	--	--	--	--	--	--	--	--
27	0	--	--	--	--	--	--	--	--	--
28	2	7.61	3.52	40.56	20.89	4.24	22.97	.22	1,393	104.41
29	0	--	--	--	--	--	--	--	--	--
30	0	--	--	--	--	--	--	--	--	--
31	1	4.55	3.64	48.01	20.02	11.72	11.26	.80	879	104.86
Total or average	675	.76	.22	35.39	39.49	14.63	8.81	.70	42,462	100.13

[1/] Includes Select Structural and Select Merchantable grades.

[2/] Includes Construction and No. 1.

[3/] Includes Standard and No. 2.

[4/] Includes Utility and No. 4.

[5/] Dollars per thousand lumber tally.

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1974. Lumber recovery from second-growth Douglas-fir. USDA For. Serv. Res. Pap. PNW-177, 20 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

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KEYWORDS: Lumber recovery studies, Douglas-fir, second-growth stands.

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